

TAP 406-2: Plotting equipotentials

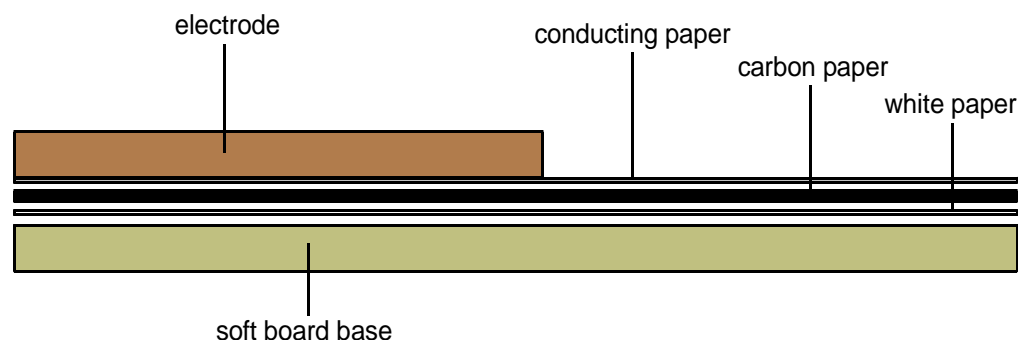
Here you study the shapes of various fields. The fields are created (in two dimensions) between conducting electrodes of various shapes on a piece of conducting paper. It will be easy to see equipotentials and their relationship to the field itself.

You will need:

- ✓ power supply, 5 V dc with one or two 4 mm leads
- ✓ multimeter with one probe
- ✓ conducting paper
- ✓ carbon paper
- ✓ plain white paper
- ✓ softboard, a little larger than A4
- ✓ various shaped electrodes made from copper strips (see below)
- ✓ eight drawing pins
- ✓ two drawing pins soldered onto 4 mm leads
- ✓ crocodile clips

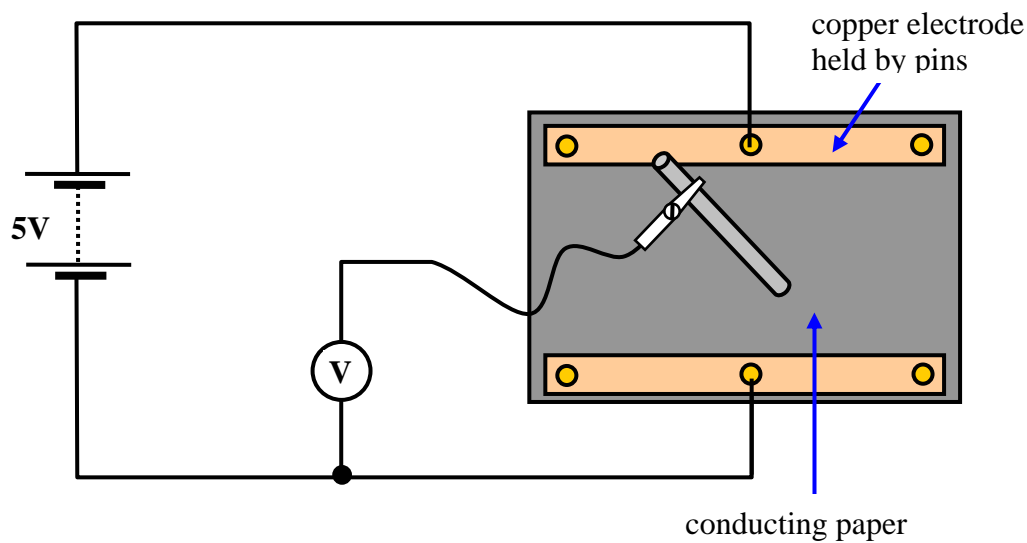
The experiment

- 1) Before you are able to make measurements, you will have to set up a 'recording system' which makes use of carbon paper below the conducting paper. Place the softboard on the bench and put a sheet of white paper on this. Cover this with carbon paper (carbon side down) and, on top, the conducting paper. All three sheets have to be held firmly in place with drawing pins at each corner.



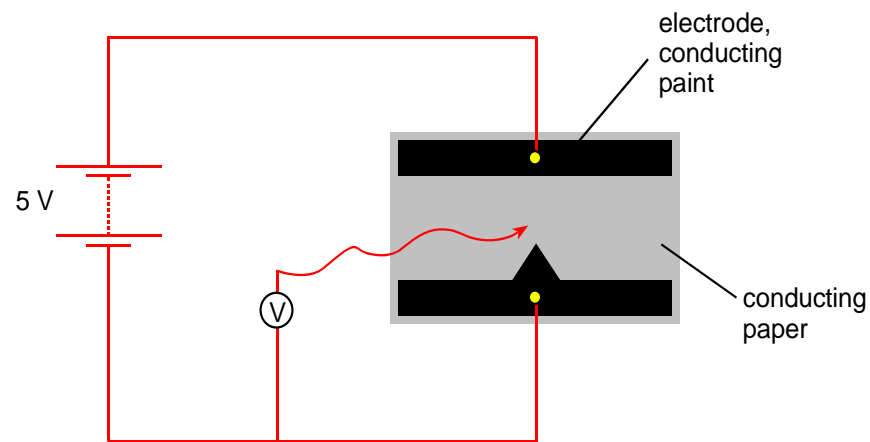
- 2) The two copper electrodes need to be secured very firmly. The diagram below shows the set-up for parallel electrodes to create a uniform field. These should be placed close to and parallel to the longer edge of the conducting paper and then secured by pushing

drawing pins through the small holes in each strip. The central hole in each strip is for a drawing pin to which a 4 mm lead has been soldered, allowing you to set up this circuit:

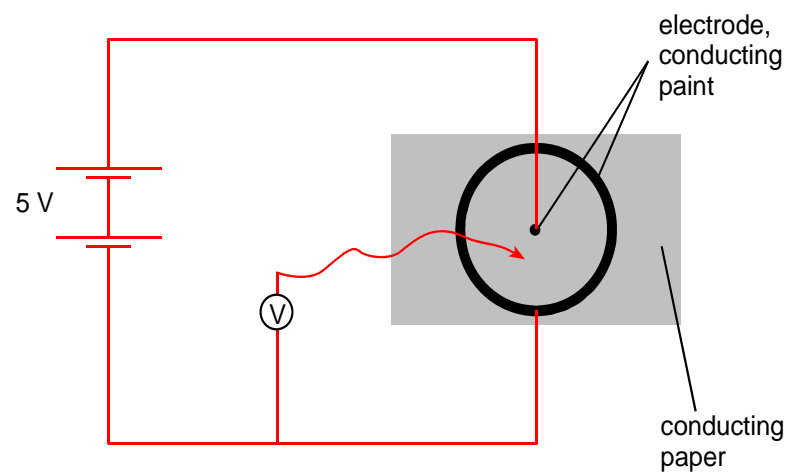


- 3) When you have set up this circuit, touch the probe on the end of the flying lead gently onto the conducting paper. The voltmeter records the potential difference between the point where the probe touches the paper and one copper electrode. You should be able to see the potential difference vary as you move from one strip to the other. If you keep the distance from each strip the same (i.e. move parallel to the electrodes), you find that the voltmeter reading does not change. You are following an equipotential.
- 4) Check that the supply is set to 5 V by placing the probe on the 'positive' strip. Now move the probe until the voltmeter reads 1 V and then push down firmly on the paper. This will make a mark on the white paper below. Find other points where the potential is 1 V and mark their position in a similar way. Five or six points will allow you to draw an equipotential when the upper layers of paper are removed (but don't remove them yet!).
- 5) Repeat the procedure described above for potentials of 2, 3 and 4 V and then mark the position of each electrode by using probe to draw round each strip. Remove the conducting paper and carbon paper, to see a series of dots on the white paper. Join these to show the position of the equipotentials.
- 6) Draw one or two field lines between the two electrodes (remember that these will be at right angles to the equipotentials, including the strips).

- 7) Repeat the procedure for other shapes of field by using electrodes of various shapes. A couple of examples are given below:



Field close to a sharp point



Radial Field

Practical advice

This is a simple introduction to field lines and equipotentials.

Simply using the end of a 4 mm plug to mark points onto the white paper below the carbon paper and conducting paper is quick and easy. There are many ways of measuring and marking the potential at a point with specially constructed probes. These can be made from graphite pencils, used ball-point pens with a lead soldered onto the metal tip, or old instrument probes. These will give a finer mark, but adequate results can be obtained from 4 mm plugs.

The electrodes can be painted using conducting paint which gives better contact but is expensive.

External reference

This activity is taken from Advancing Physics chapter 16, 60E, 220E, 240E